A Dissertation

on

The Capillary Circulation

By

Mason L Weems

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The Capillary Circulation

Previous to advancing our opinion on this subject, we will briefly survey the vessels whose function we are to consider. In this we will follow Bichat from whom we derive our ideas on this subject.

The capillaries are vessels located between the arteries and veins, they perform the function of nutrition, and from them proceed the exhalants, and excretories. They are infinitely small and are infinetely divided throughout all organs. Bichat says. "All" (meaning organs) "are in fact composed of an infinity of capillaries which cross, unite, separate, and unite again by communicating in a thousand ways with each other." The same writer observes. "It is in this view that we may with truth consider the

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animal body as an assemblage of vessels."
These vessels do not all convey the same fluid.
There are some organs whose capillaries convey red blood only; others convey both red and white blood; and again others whose vessels convey white blood alone. First, of those organs whose capillaries convey red blood only. These are the muscles, the Spleen, some parts of the Mucous system as the pituitary membrane, &c. We can find nothing but red blood in their capillaries, and they seem made up of red vessels. Secondly, of those whose capillaries convey both red and white blood. These are the Serous membranes, the bones, the cellular texture, part of the fibrous system, the skin, glands, &c. Let us take the peritoneum as an example. In a healthy state its vessels contain but little red blood; to this it owes its transparency, but if it is irritated the sensibility of its vessels is changed and they admit, or take the

red blood, which was inimical to their sensibility when in a natural state, and the membrane becomes highly coloured. So with the other organs mentioned, in disease, or the skin of the cheeks and neck in emotions of the mind. Again, in conjunctivitis we can distinguish with the naked eye innumerable vessels conveying red blood, which in health were invisible, owing to the absence of that fluid; in some cases a few of these vessels seem to have acquired a sensibility to red blood and ever after convey it. We have considered a few of those organs with one force; Bichat says "The others present the same phenomenon, we shall see that the cellular texture, certain fibrous, &c. &c. examined comparatively on the one hand in animals that we dissect alive, on the other in an inflammatory state or after fine injections, present a much less number of vessels in the first than in the second case." The quantity

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of blood in the different organs of this class varies considerably, thus the serous membranes contain very little, the skin, more, the mucous membranes, a considerable quantity &c.

Thirdly, of those organs whose capillaries, convey white blood only. These are the tendons, the cartilages, hair, &c. In health they contain no red blood and in fact appear inorganized, but their internal growth proves their organ-ization, and it is frequently demonstrated by inflammation and fine injections.

2ly Their anastomosis. There is evidently a free communication between these vessels. In a fine-ly injected serous, or mucous membrane we can perceive innumerable vessels which inosculate with each other at almost imperceptible dis-tances; and in fact these membranes seem composed of a net work, of vessels which traverse them in every direction. Some of

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these vessels invisible in health, unite in the same manner with others that are visible in that state: there is then a free communication between the vessels conveying red blood, and those which convey white; yet in health the blood of the former does not pass into the latter. 3d Their structure. Owing to the diminutive size of these vessels, no demonstration can be made of their structure; we however believe it vary materially in the different organs; because, when it is considered that all parts, are almost entirely composed of them, we cannot for a moment suppose their structure to be the same in organs whose structures are entirely different, as the muscles, tendons, &c. Besides, a difference of secretion supposes, a difference in sensibility, contractility, and structure; thus the saliva, and pancreatic juice, are secreted by glands

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closely resembling each other in structure; but the urine, bile, &c; are secreted by glands differing as widely in structure as those fluids do in their properties.

Having thus considered in a general view, the capillaries, as indispensable organs of all living bodies; we will now go on more particularly to the object of this paper,

The Circulation in the Capillaries

This we will divide with Bichat, into the motion of the fluids, and the changes they undergo. The blood after it enters the capillaries, we believe to be without the influence of the heart: it then moves by the contractility of those vessels, in the same manner that the chyle moves in the lacteals the juices of plants in their vessels &c &c.

Our arguments in support of this doctrine; first taught by Bordeu, and admirably

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1st The difference in the motion of the fluid which comes to these vessels by the arteries, and those which leave them by the veins, excretories, &c. First of the veins. No one to my knowledge has ever seen the pulsation of a vein; yet if the blood still retains the impetus given to it by the heart, they should possess this motion; because, the aggregate impulse of the blood from the capillaries would be equal to that from the artery which supplied them; a sufficiency of impulse would then be given to the blood in the veins to produce a pulse. We are conscious however that those who differ from us, advance the yielding nature of the veins, to account for the absence of pulsation, in them: but we think their reason is fallacious. For, if they will select a clear vein in a horizontal position, and strike gently and

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quickly on the end most remote from the heart, the pulsatory motion (which sometimes may be perceived 10 or 12 inches up the vein) will convince them that the veins would admit of that motion from the capillaries. There is then nothing to prevent this motion in the veins: therefore as it does not take place we may reasonably infer its nonexistence in the capillaries.

Secondly, the Excretories and Exhalants. Their action is not in proportion to the action of the heart and arteries. We believe on the contrary that in agitations of the arterial system the secretions, and excretions, as those of the skin kidneys &c.; are nearly suspended, and it is only when the fever has abated, or gone off, that they recommence.

This seems not only to prove the independence of the circulation in these vessels, but also their intimate connexion with the disease. On the other hand from the immoderate use of Tobacco, or

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some other article of the same class, the pulse is considerably reduced; yet there is generally an increase of perspiration, urine, &c. Now if the blood moved through the capillaries by the influence of the heart, these cases would reversed.

II. How can the resuscitation of persons supposed to have been dead be accounted for. There can be no doubt of persons having laid in that condition for two or three days and finally recovering their natural powers of life. Now all must agree that the circulation continued in these cases; and we think all will agree as to the moving power; for this cannot be the heart, because we can perceive no motion at it or in the arteries, and it seems impossible to us that a sudden motion could be given to a column of fluid in an elastic tube, without its being perceptible. If then the heart is not the moving power; the capillaries are the only organs to which we can look; these however are

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equal to the task, and we believe the phenomenon can be explained on no principle but that of the independence of the capillary circulation. Upon this principle it may be accounted for, thus,- The organic sensibility and contractility of the capillaries remaining, the blood is conveyed by them from the arteries, into the veins these (not having the weight of the blood to contend with, and being still in possession of life and contractility;) are in a contracted state, and cannot contain all the blood in the system; (as in death,) it therefore passes from them into the heart, thence, influenced all the while by the capillaries, into the arteries, and again goes the round of the circulation. In the lungs it is changed as usual by the small quantity of air, which, in these cases circulates through them, and is competent to the purpose as the blood moves slowly. In favourable cases this process continues to increase the sensorial power (or Darwin terms it)

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until the heart is gradually brought into play, and animal life is finally restored.

On this principle we might explain the continuance of perspiration after death. Again, on the same principle, the absence of blood in the arteries might be accounted for: this is strengthened by the fact that in death from lightning, hanging &c the blood remains in the arteries. The application of the principle in these cases, is easy.

III How can the recession of blood, in the cold stage of of intermittent fever be accounted for? It cannot be owing to any change in the temperature, because, admitting there was a change, it would be nearly as apt to affect one person as another. Neither does it arise from a diminished action of the heart, for we have seen cases wherein it was much more reduced without any such effect taking place; besides, why are the internal organs in a state of congestion? why does not the heart

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throw the blood to the surface with as much force as to these organs? No answers appear, therefore we will reject the hypothesis. We will now attempt an explanation on the principle which we are endeavouring to establish. Thus, the organic sensibility of the capillaries, of the skin, is altered by the sympathy existing between them, and the original seat, of the disease: now the blood is, to this altered sensibility, a foreign substance, and is refused admission: this accounts for the constriction and coldness of the surface. It is evident then that a much less quantity of blood than natural, can be disposed of in the capillaries of the surface, consequently a greater quantity thrown into the internal organs producing congestions of them. These may be removed by blood letting which lessens the quantity in the general system, or by an emetic which lessens the quantity in the organ by equalizing the circulation. This effect

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is produced by a well known sympathy between the stomach and skin.

IV How can the old axiom, "Ubi irritatio ibi afflux us" be explained if we believe the heart the sole moving agent of the circulation? In the application of a blister, or any other cause of inflammation, to a part; how could we account for a determination to that part? How can the heart have any thing to do with this determination? if its action was increased it would be more reasonable to suppose a determination to all parts than to one. There could then, according to this supposition be no local inflammations, all inflammatory affections, would be general.

On the other hand, admit the independence of the capillary circulation, and all difficulty is removed. We will then see how local inflammation takes place, and may explain it, as also the modification of that process in the different tissues.

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Thus, if an irritant is applied to a part, a change is produced in the sensibility of its capillaries, and they are placed in a relation to the red blood which is now freely received, and as freely flows to them. This we will endeavour to explain. We all know that the arteries are constantly more or less distended with blood. It then follows as a natural consequence that when an artery is wounded a greater quantity of blood will pass into it than when it is sound. Now the capillaries arise from the arteries, and take from them the fluids ordained for their several functions. It is then evident to all that, if the sensibility of these vessels is altered, and they take from the artery a greater than natural, quantity of blood, the effect will be the same as that produced by the wound i.e there will be an increased afflux into the artery. We have thus explained the afflux, which produces the second phenomenon of inflammation,

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to wit, redness. The sensations which are in gradation from a simple itching, to the most violent pain, are owing to the organic sensibility of the capillaries becoming animal, whereby impressions which were previously confined to the vessels themselves, are now transmitted to the brain. It would be too far from my object to consider the cause of the swelling, we will therefore pass on to the modification of inflammation in the different tissues.

Supposing an impossibility; that local inflammation could take place, if the heart were the sole moving power of the circulation, how could the advocates of this opinion account for the modification of it in the different tissues? We cannot imagine in what manner they could attempt an explanation, of a fact, which none can doubt, therefore we will endeavour to make up their deficiency. It has been shown that there are organs whose capillaries differ from the capillaries of other organs

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in structure. Their sensibility and contractility must also differ, because the function of some of these vessels is to secrete bone, others muscle, brain &c. Now if their structure, sensibility, and contractility are different it is evident their diseases will be different. The causes of inflammation will also act differently for some are affected by the direct application of the cause, others seem only to be affected by sympathy; except in cases of wounds. The peritoneum is an example of this. There is also some difference in the causes, for instance, air in contact with the tunic conjunctiva, or with the mucous membranes produces no effect, but it generally produces inflammation of the peritoneum if brought into contact with it. Now it is evident from what has been said, that inflammation is different in the different tissues. it is still inflammation, but it is modified by the part in which it exists. In mucous membrane it is acute and moves rapidly through its different stages; but in the tendons, bones, &c. it is

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much more chronic. The inflammation in these organs seems to be in proportion to the activity of their circulation. We see by the tardiness with which union is effected in a fracture of a bone, a like tardiness in its circulation. While on the other hand in the rapidity with which lost substance is replaced in a mucous membrane, we see an image of its lively circulation.

V If the heart was the sole moving agent of the circulation, the blood would pass indiscriminately into all the vessels. This would take place notwithstanding the arrangements of Boerhaave for the circulation. But as the capillaries are not inanimate tubes but have a consciousness, will, and contractility of their own, nothing is permitted to enter them but fluids which are in relation to their sensibility.

Were it not for this faculty, there would be no separation of the fluids, all vessels would convey red blood, and all parts would be red

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As to the changes which take place, we only know that in the lungs the venous, or black blood is changed into arterial or red blood; and that in the general capillary system it is vice versa. In what manner this is effected, whether by the addition or subtraction of some principle, we believe has not been satisfactorily determined.

We have now brought to a conclusion our essay on the Capillary Circulation. Two things we hope have been proven, 1st The Independence of the Capillary Circulation and 2ly That the arteries should be considered as resembling, more a set of reservoirs than pipes for forcing pumps